

# Vectors

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## I. Draw the following vectors to scale.

- 1) 250m at  $35^\circ$  with the horizontal
- 2)  $1.5\text{m/s}^2$  at  $38^\circ$  E of N
- 3) 98km S $72^\circ$ W
- 4) 0.56km/h at  $46^\circ$  with the vertical
- 5) 37.2km/h from  $21^\circ$  W of N
- 6) 580km/h at a course of  $162^\circ$
- 7) 29m/s from a course of  $313^\circ$
- 8) 74m/s at  $63^\circ$  with the horizontal
- 9) 0.38cm at N

## II. Addition of vectors (graphical)

- 1) a = 320m downward  
b = 140m upward
- 2) a = 5.6 km horizontal  
b = 3.7 km vertical
- 3) a =  $3.97\text{m/s}^2$  at S $17^\circ$ E  
b =  $9.2\text{m/s}^2$  at S $84^\circ$ W
- 4) c = 72km at a course of  $72^\circ$   
j = 38km at a course of  $232^\circ$
- 5) a = 210km/h N $18^\circ$ W  
b = 85km/h S $57^\circ$ W
- 6) a = 350km/h S $37^\circ$ E  
b = 80km/h N $14^\circ$ E
- 7) a = 120km/h on a course of  $315^\circ$   
b = 75km/h from a course of  $48^\circ$

## III. Subtraction of vectors (graphical)

- 1) a = 16.2 m horizontal  
b = 7.8m vertical
- 2) l = 4.6cm right  
m = 3.7cm left
- 3) c = 380m S $24^\circ$ E  
d = 475m N $18^\circ$ E
- 4) e =  $0.47\text{m/s}^2$  on a course of  $54^\circ$   
f =  $0.23\text{m/s}^2$  on a course of  $123^\circ$

## IV. Addition of 3 or more vectors

- 1) a =  $5.6\text{m/s}^2$  course of  $115^\circ$   
b =  $6.7\text{m/s}^2$  course of  $38^\circ$   
c =  $5.1\text{m/s}^2$  course of  $176^\circ$
- 2) a = 9.4 km at  $29^\circ$  E of S  
b = 1 4.6km at  $72^\circ$  E of N  
c = 8.7km at  $31^\circ$  W of N
- 3) a = 35km/h at S $36^\circ$ W  
b = 47km/h at N $17^\circ$ W  
c = 53km/h at S $5^\circ$ E  
d = 31km/h at N $42^\circ$ E

## V. Resolving vectors into horizontal and vertical components

- 1) 3.8m/s on a course of  $284^\circ$
- 2) 175km at N $32^\circ$ W
- 3)  $24.6\text{m/s}^2$  at  $41^\circ$ W of S
- 4) 9.7m on a course of  $98^\circ$
- 5) 23cm/s at N $21^\circ$ E

## VI. Solving word problems involving vectors

- 1) An airplane flying at 250 km/h on a course of  $280^\circ$  is subjected to a wind of 75 km/h from a course of  $39^\circ$ . Find the plane's actual velocity in relation to the ground. (295 km/h  $268^\circ$ )
- 2) A canoe is headed directly east at 0.58 m/s. A current of 0.26 m/s is flowing south and in addition a 0.94 m/s wind is blowing from  $N29^\circ E$ . Find the canoe's resultant velocity. (1.1 m/s  $S6^\circ E$ )
- 3) A pilot wishes to fly her plane at 180 km/h along a course of  $80^\circ$ . In order to do this, she must compensate for a 56 km/h wind blowing from a course of  $125^\circ$ . Find the velocity at which the pilot should fly to reach her destination. (220 km/h  $90^\circ$ )
- 4) A fisherman wants to navigate at 7.5 m/s to a point directly north of his starting point. However, the current is flowing toward the west at 2.5 m/s and a wind of 2.1 m/s is blowing from  $S75^\circ E$ . Find the proper velocity the fisherman should travel to reach his desired location. (8.3 m/s  $N33^\circ E$ )
- 5) A 110 N force and a 55 N force both act on an object at point P. The 110 N force acts at  $90^\circ$ . The 55 N force acts at  $0^\circ$ . What is the magnitude and direction of the resultant force? (120 N  $63^\circ$ )
- 6) A motorboat travels at 8.5 m/s. It heads across a river 110 m wide.
  - a. If the water flows downstream at a rate of 3.8 m/s, what is the boat's resultant velocity? (9.3 m/s  $24^\circ$ )
  - b. How long does it take the boat to reach the opposite shore? (13 s)
- 7) A boat heads directly across a river 41 m wide at 3.8 m/s. The current is flowing downstream at 2.2 m/s.
  - a. What is the resultant velocity of the boat? (4.4 m/s  $30^\circ$ )
  - b. How much time does it take the boat to cross the river? (11 s)
  - c. How far downstream is the boat when it reaches the other side? (24 m)
- 8) A 42 km/h wind blows towards  $215^\circ$ , while a plane heads toward  $125^\circ$  at 152 km/h. What is the resultant velocity of the plane? (160 km/h  $140^\circ$ )
- 9) An airplane flies  $149^\circ$  at 525 km/h. What is the magnitude of the component of the plane's velocity
  - a. toward  $90^\circ$ ? (270 km/h)
  - b. toward  $180^\circ$ ? (450 km/h)
- 10) A hiker walks 14.7 km at an angle of  $305^\circ$  from the east. Find the east-west and north-south components of his walk. (8.43 km E and 12.0 km S)
- 11) Three forces act simultaneously on point J. One force is 10.0 N North; the second is 15.0 N west; the third is 15.0 N  $N30^\circ E$ . Determine the magnitude and direction of the resultant force. (24.2 N  $108^\circ$ )
- 12) A weather station releases a weather balloon. The balloon's buoyancy accelerates it straight up at  $15 \text{ m/s}^2$ . At the same time, a wind accelerates it horizontally at  $6.5 \text{ m/s}^2$ . What is the magnitude and direction (with reference to the horizontal) of the resultant vector? ( $16 \text{ m/s}^2$   $67^\circ$ )
- 13) Kyle wishes to fly to a point 450 km due south in 3.00 h. A wind is blowing from the west at 50 km/h. Compute the proper heading and speed Kyle must choose in order to reach his destination in time. (158 km/h  $S18.4^\circ W$ )
- 14) On a day when the wind is 80.0 km/h from the west, an airplane is aimed  $W65^\circ N$  and flown at a speed of 320.0 km/h. How far and in which direction will the plane fly in 20.0 minutes? (295 km  $N11^\circ W$ )
- 15) A boat is heading directly north across a river at 5.0 km/h. The river is flowing east at 3.0 km/h.
  - a. What is the actual velocity of the boat? (5.8 km/h  $31^\circ$ )
  - b. How far downstream does it land if the trip takes 0.5 h? (1.5 km)
  - c. How wide is the river? (2.5 km)

- 16) An airplane moves in a north-westerly direction at 125 km/h relative to the ground due to the fact there is a westerly wind of 50 km/h relative to the ground. How fast and in what direction would the plane have travelled if there was no wind? (164 km/h N57°W)
- 17) On a day when the wind is blowing 70 km/h W40°S you wish to fly to a destination 830km S30°E in 1.5 h. What heading and speed should you fly your plane? (540 km/h S38°E)
- 18) A river has a current of 6.0 km/h. What speed must a boat be able to travel to go straight across the river when it is aimed 60° upstream? (6.9 km/h)
- 19) It is a distance of 500 m straight east to get across a river. The river has a current of 3.7 m/s straight south. You have a boat that can travel at 10.0 m/s.
  - a. Which way must you aim the boat to get directly across the river? (21.7°)
  - b. How long will it take you to cross the river? (53.8 s)
- 20) A boat can travel 7.5 m/s. Which way must it be aimed to travel directly across a river with a current of 3.6 m/s? (28.7° downstream)
- 21) What is the true velocity of an airplane flying 350 km/h N in a wind of 70 km/h W40°S? (310 km/h N10°W)
- 22) Two towns A and B are situated directly opposite each other on the banks of a river whose width is 8 km and which flows at a velocity of 4 km/h. A man located at A wishes to reach town C which is 6 km upstream from and on the same side of the river as town B. If his boat can travel at a maximum velocity of 10.0 km/h and if he wished to reach town C in the shortest possible time, what course must he follow and how long will the trip take? (55.6° upstream 1.41 h)

## VII. Scalar Multiplication and Division

- 1)  $\frac{1}{2}(75.2\text{ m/s } N34^\circ E)$
- 2)  $3.14(8940\text{ m on a course of } 218^\circ)$
- 3)  $(144\text{ km } N56^\circ E) \div 6$
- 4)  $(1.65\text{ m/s}^2 \text{ at } 111^\circ) \div 0.05$